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REPORT OF
INSPECTION OF PLASTER WORK AT
ALASKA NATIVE SERVICE HOSPITAL
AND TESTS FOR QUALITY AND
CHARACTERISTICS OF PLASTER MATERIALS

By

Nolan D. Mitchell

Requested by the
Bureau of Indian Affairs



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REPORT OF INSPECTION OF PLASTER WORK
AT ALASKA NATIVE SERVICE HOSPITAL AND
TESTS FOR QUALITY AND CHARACTERISTICS
OF PLASTER MATERIALS

1. INTRODUCTION

Pursuant to a request from the Bureau of Indian Affairs, Department of the Interior, dated February 13, 1953, an inspection was made to determine the condition of plaster in the main hospital building and the quarters buildings for nurses and help at the Alaska Native Service Hospital, Anchorage, Alaska, on February 21, 22, 23, 1953. Participating in the inspection were Messrs. Lansing S. Wells, William C. Cullen, and Nolan D. Mitchell of the National Bureau of Standards. The report of this inspection and related tests supplement a letter of this Bureau dated June 16, 1952, and a report 9.8/G-10015 dated September 17, 1952, both signed by Lansing S. Wells.

Among representatives of the Department of Interior, Bureau of Indian Affairs, who were contacted at the job were:

Mr. John J. Finley, Chief, Building & Utilities Branch, Wash., D.C.
Mr. L. T. Burn, Architectural Engineer, Bldg. & Util. Br., " "
Mr. H. T. McCurdy, Chief, Mech. Engineers, " " " "
Mr. J. C. Helfrich, Electrical Engineer, " " " "
Mr. Harry Halverson, Area Chief,
Bureau Indian Office, Juneau, Alaska
Mr. V. P. Reimer, Project Engineer,
Alaska Native Service Hospital, Anchorage, Alaska

2. INSPECTION OF QUARTERS BUILDING

The first inspections were made in the quarters building because the construction there was nearing completion. Fifteen of twenty rooms and the corridors in the help's quarters section were found to have cracks in the plaster. Cracks were observed in rooms 200, 201, 207, 209, 212, 214, 215, 217, 303, 309, 311, 321, 325, 329, 331, and in the corridor wall in the vicinity of room 303. A number of cracks extended from the corners of electrical outlet boxes. Some of the ceiling cracks extended from electrical outlets toward the walls. The direction of the larger wall cracks was usually more or less vertical. Many of these more prominent cracks were intersected by narrower cracks extending laterally from the main cracks. Many of the thin cracks were in random directions in a pattern known as map cracking.

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... which will be made up of a number of firms
which will be selected, agreed to by the trustees
and it is to be understood that they are held
responsible for all the work done by the building industry
and, as far as possible, to be evaded, and it is also
understood that no compensation will be given to any
individual or firm for loss of time or expense
or delay due to any cause, so long as the same can be shown
to be due to the fault or negligence of the contractor
and his agents.

15000, retained by the original and its contemporaries (no. 1
1500, col. 3) from the original and now, probably, neither to

Not only were there cracks in the plaster but a number of the ceramic wall tiles in the wainscots of bathrooms and toilet rooms were found to be broken, and in a number of places wall tiles were found to be loose from the backing of portland cement plaster on metal lath. Wall tiles were removed from the wainscot in one location, and equally spaced horizontal shrinkage cracks in the cement plaster base were observed in the height of the wainscot.

3. INSPECTION OF MAIN HOSPITAL BUILDING

The inspection of the Hospital Building to determine the condition of the plaster included visits to approximately sixty percent of the total number of rooms and all corridors. A careful inspection of the condition of the concrete of the exterior walls was also made to determine whether defects of concrete work might have contributed to the failure of the plaster. The plaster on metal lath for corridor and room partitions, without exception, was found to be cracked or had been cracked and repaired. A large proportion of the plaster surfaces had been painted, but cracking appeared to have continued subsequent to the application of the paint. There were few boxes for outlets for electrical services where cracks were not found to radiate from one or more corners. The general cracking was of the pattern known as map cracking. The spacing of cracks ranged from a few inches to about three feet.

Specimens of plaster for laboratory tests and analyses were cut from rooms and corridor as shown in table 1. The 15- by 15-inch specimens as cut from partitions for tests to determine the stability of the plaster when subjected to changes in relative humidity included the metal lath as well as the plaster. Those for analysis to determine the proportions of plaster and aggregates were approximately 10 inches square and did not include lath or plaster keys.

and the *Winnipeg Free Press* and *Winnipeg Journal* could not agree to
allow the *Winnipeg Free Press* to publish the letter of protest and to let
the *Winnipeg Journal* publish it instead. And so it was that the letter was published
in the *Winnipeg Journal* against the *Winnipeg Free Press* and the *Winnipeg Free Press*
against the *Winnipeg Journal*. And this was the result of the decision
not to have the two papers publish the letter together.

THE WINDSOR JOURNAL AND THE WINNIPEG FREE PRESS

The *Winnipeg Free Press* and *Winnipeg Journal* are the two largest
newspapers in the city of Winnipeg. They are both owned by the same
company, the *Winnipeg Free Press* and *Winnipeg Journal* Company.
The *Winnipeg Free Press* is the larger of the two newspapers,
and the *Winnipeg Journal* is the smaller. The *Winnipeg Free Press* is
also known as the "Daily Free Press" and the *Winnipeg Journal*
as the "Daily Journal". The *Winnipeg Free Press* is a daily newspaper
published every day except Sunday. The *Winnipeg Journal* is a
weekly newspaper, published every week except Sunday.
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Table 1. Source or location of specimens
of lath and plaster for laboratory tests

Story	Wing	Room	Tests
Basement	South	Corridor	Analysis and stability
Do	do	12	Analysis
First	East	106	Analysis and stability
Do	West	182	Stability
Second	North	245	Analysis
Third	East	316	Analysis
Do	West	318	Stability
Fourth	South	438	Analysis
Fifth	West	504	Analysis
Do	South	523	Stability
Do	do	{Closet} 523	Stability

4. MATERIALS FOR AUXILIARY TESTS

Bags of materials were secured from the same sources from which plaster, lime, and aggregates for the building plaster came. The gypsum cement plaster, gauging plaster, and finishing lime were bought from Pioneer Sand and Gravel Co., 901 Fairview North, Seattle, Washington. The plaster supplied by this concern was from the Sigurd, Utah, plant of United States Gypsum Co., and the lime was "Miracle" brand from U. S. Lime Products Corporation, Henderson, Nevada. The vermiculite aggregate was from the Portland, Oregon, plant of Vermiculite Northwest, Spokane, Washington, and the sand was obtained by Mr. V. P. Reimer, Project Engineer, from Anchorage, Alaska, who also forwarded retained samples of plastering materials from his office.

5. CHARACTERISTICS OF PLASTERS

Characteristics of the plasters and hydrated lime are given in tables 2 and 3. These materials conform to applicable Federal specifications. Analyses of plaster materials found in specimens of the set plasters are given in tables 4, 5, and 6. The proportions of gypsum cement and aggregates in the set-plaster samples were determined by dissolving the gypsum from weighed amounts of dried set plaster in ammonium acetate solution, then washing and weighing the residue after it had been dried at 70° C. The gypsum cement plaster was found to be 96.15 percent soluble; therefore, when the weight of the soluble portion of the sample of set plaster was divided by 0.96, the quotient gave the weight of the gypsum plaster from which the percent of gypsum plaster in the mix was computed. The ratio of sand to vermiculite in the aggregates was determined from the weights of the two constituents. It was found that the sand used in the plaster had a fairly definite proportion of a magnetic constituent. By the use of a magnet a large part of the magnetic material could be extracted from the mixture of aggregates. It was reasoned that the ratio of magnetic material extracted from the mixed aggregate to that of magnetic material extracted from the sand would be the ratio of sand to that of the combined aggregates. The proportions of sand and vermiculite and the number of cubic feet of each per 100-lb. bag of gypsum plaster were computed on that basis.

Table 2. Characteristics of gypsum plasters

[By Federal Specification SS-P-402, except as otherwise stated]

Plaster sample designation	Type	Time of set	Tensile strength	Compressive strength	$\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$
		hrs	psi	psi	%
U. S. Gypsum, fibered ¹	N	24	190	---	90.9
U. S. Gypsum, not fibered ²	N	10 1/2	225	---	90.3
U. S. Gypsum, medium set gauging ²	G	2 1/4	540	---	93.0
U. S. Gypsum, fibered ² Do (with Alaska sand)	N	7 1/2	240	3 1190	92.8
Do	N	5 1/4	185	3 1030	
(Fed. Spec. SS-P-401) Do	N	8	350	3 1930 (avg. 2 lots)	
(Fed. Spec. SS-P-401, but with 150 g needle for consistency)	N	---	365	3 1880	
U. S. Gypsum gauging ²	G	2	540	2470	98.3

¹ Sample of plaster approved for project.² Sample purchased from dealer who supplied material for project. All of 25 g of gauging plaster passed through No. 100 sieve.³ The cubes of the four plaster mixes in this group exhibited volumetric shrinkage as follows: 2.0 percent; 0.6 percent; 2.2 percent (avg. of 2 lots); and 3.0 percent, respectively.

73625 1876-1912 1912 1912

age, Alaska

CO_2 (non-volatile basis)	$\text{MgO} / (\text{CaO} + \text{MgO})$	Total MgO hydrated	$\text{CaO} + \text{MgO}$ unhydrated	Autoclave expansion
0.70	40.9	97.3	0.81	—
0.94	40.5	97.9	.62	—
2.50	39.6	97.3	.76	0.03

3375 - 1938 Jr. 12 " 9 " 3 A

[A] 1960-1961 20 32000 1961-1962 20 32000

Table 3. Characteristics of hydrate lime used in site-c at winter for Alaska Native Service on 100.0°C., Jan. 9
(as is - no temperature)

Sample designation	Fineness		Xide content				Wet composition				(nonvola- tile resin)	Volatile ls	CO ₂ / H ₂ O	Total %C hydrated	SO ₃ + unhydrated	Mo + CO ₂	Autoclave expansion		
	through 20	200	lasticity	%	%	CaO	CaO	Ca(OH) ₂	%	SiO ₂ + R ₂ O ₃									
Lime Products Corp. "Iracal" calomitic, recrystallized (small can)	100.0	95.1	50	26.47	.85	42.87	2.68	.14	55.80	41.77	0.81	.85	99.3	0.70	40.9	97.3	0.81	---	
"Iracal" (medium can)	100.0	93.2	550	26.51	.63	42.71	2.44	1.57	56.06	41.70	.62	.63	99.0	.94	40.5	97.9	.62	---	
✓	100.0	93.2	430	1.85	25.50	69	43.32	2.39	4.21	54.12	3.95	.78	.69	96.7	2.50	3.6	9.3	.78	-0.03

✓ Lime purchased from dealer who supplied materials for the project. All other samples were retained as proved samples from the project.

Table 4. Analysis of base-coat plaster for proportion of aggregates by ammonium acetate method
(Basis: Material dried at 50° C)

Sample designation	Weight of sample	Total insoluble	Total insoluble	Magnetic content extracted
				g
U.S. G. "Red Top" fibered gypsum plaster ¹	3.9945	0.1490	3.73	---
	5.0030	.1925	3.85	---
	5.0037	.1948	3.89	---
	5.0032	.1992	3.98	---
	5.0033	.1901	3.80	---
			(Avg. 3.85)	
Vermiculite ²	4.9975	5.0072	100.19 (Soluble: none)	0.0000
Alaska sand ³	19.9500	19.8635	99.57 (Soluble: 0.43)	.7920 (Avg. of 6 determinations)
Base-coat plaster⁴				
B hall	9.9905	4.6336	46.78	0.1565
Do	10.0025	4.5300	45.29	.1580
Average	9.9965	4.5819	46.04	0.1568
N 12	9.9875	3.2155	32.20	.0318
Do	10.0010	3.4143	34.14	.0320
Average	9.9943	3.3149	33.17	0.0319
E 106	9.9860	2.5108	25.14	---
Do	10.0005	2.6432	26.43	0.0000
Do	10.0015	2.6422	26.42	.0000
Average	9.9996	2.5991	26.00	0.0000
N 245	9.9900	3.4605	34.64	0.0500
Do	10.0007	3.5407	35.40	.0375
Average	9.9954	3.5006	35.02	0.0473
E 316	9.9925	5.4580	54.99	0.1240
Do	10.0005	4.5940	45.94	.1250
Do	10.0000	4.6195	46.20	.1265
Average	9.9978	4.8295	49.04	0.1252
S 438	9.9900	4.4018	44.06	0.0915
Do	10.0002	4.4860	44.86	.0915
Average	9.9951	4.4479	44.46	0.0915
W 504	9.9800	3.4795	34.86	0.0650
Do	10.0005	3.7210	37.21	.0560
Average	9.9903	3.6003	36.04	0.0605

¹ Sample of plaster from dealer who supplied plaster for project.

² Sample of vermiculite aggregate from Vermiculite Northwest who supplied aggregate for project.

³ Sample of sand supplied by Project Engineer as representative of material used on project.

⁴ Base-coat plaster samples taken from walls of hospital building. Letters signify, respectively: B, basement; N, North; E, East; S, South; W, West, and figures denote the room number as given on architectural plans. The proportion of aggregate were determined from analyses of these samples.

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e, Alaska

Sample designation	g0 e. ed	Ratio, lime putty to $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ in original mix	Apparent MgO in lime used	Thickness of the white coat
B hall	11	3.5+	41.4%	< 1/64 - 1/16 in.
N 12	10	0.95+	40.0	1/16 - 3/32
E 106	11	2.0-	38.7	1/32 - 1/16
H 245	10	1.3-	47.9	1/32
E 316	10	3.3-	39.6	1/32 - 1/16
S 438	12	1.4-	39.8	1/16
W 504	4	0.81-	51.7	< 1/64 - 1/16

1 Letters signify:

2 Samples designated from the base coal mineral containing a considerable percentage of MgO) on the assumption that the white coat consists of nothing other than

3 The excess H_2O

Table 4. Analysis of base-coat plaster for proportion of aggregates by ammonium acetate method
(Basis: Material dried at 50° C)

Sample designation	Weight of sample	Total insoluble	Total insoluble	Magnetic content extracted
U.S. G. "Red Top" fibered gypsum plaster ¹	5	5	5	5
Do	3.9945	0.1490	3.73	---
Do	5.0030	.1925	3.85	---
Do	5.0037	.1948	3.89	---
Do	5.0032	.1992	3.93	---
Do	5.0033	.1901	3.80	---
			(Avg. 3.85)	
Vermiculite ²	4.9975	5.0072	100.19 (Soluble: none)	0.0000
Alaska sand ³	19.9500	19.8635	99.57 (Soluble: 0.43)	.7920 (Avg. of 6 determinations)
Base-coat plaster ⁴				
B 111	9.9905	4.6335	46.78	0.1565
Do	10.0025	4.5300	45.29	.1580
Average	9.9765	4.5819	46.04	0.1568
B 12	9.9875	3.2155	32.20	.0318
Do	10.0010	3.4143	34.14	.0320
Average	9.9943	3.3149	33.17	0.0319
B 106	9.9860	2.5108	25.14	---
Do	10.0005	2.6432	26.43	0.0000
Do	10.0015	2.6422	26.42	.0000
Average	9.9996	2.5991	26.00	0.0000
B 245	9.9900	3.4605	34.64	0.0500
Do	10.0007	3.5107	35.40	.0775
Average	9.9954	3.5006	35.02	0.0478
B 316	9.9925	5.4580	54.99	0.1240
Do	10.0005	4.5940	45.91	.1250
Do	10.0000	4.6195	46.00	.1265
Average	9.9978	4.8775	47.04	0.1252
B 438	9.3900	4.4018	44.06	0.0915
Do	10.0002	4.4860	44.86	.0915
Average	9.9951	4.4439	44.46	0.0915
B 504	9.2800	3.4795	34.86	0.0650
Do	10.0005	3.7210	37.21	.0560
Average	9.9903	3.6003	36.04	0.0605

¹ Sample of plaster from dealer who supplied plaster for project.

² Sample of vermiculite aggregate from Vermiculite Northwest who supplied aggregate for project.

³ Sample of sand supplied by Project Engineer as representative of material used on project.

⁴ Base-coat plaster samples taken from walls of hospital building. Letters classify, respectively: B, basement; 1, north; 2, east; 3, south; 4, west, and figures denote the room number as given on architectural plans. The proportion of aggregates were determined from analyses of these samples.

Table 5. Trace of white-coat plaster finite from walls of Alaska Native Service Hospital, near Fairbanks
(analysis material dried at 50°C)

sample designation	oxide content			Compound Composition								Total MgO of lime hydrated	ratio, lime putty to $\text{CaCO}_4 \cdot 1/2\text{H}_2\text{O}$ in original mix	apparent MgO in lime used	Thickness of the white coat		
	SiO_2	Al_2O_3 (combined)	$\text{TiO}_2 + \text{Fe}_2\text{O}_3$	CaO	MgO	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	CaCO_3	$\text{Ca}(\text{OH})_2$	$\text{Mg}(\text{OH})_2$	MgO excess	$\text{SiO}_2 + \text{Al}_2\text{O}_3$	$\text{TiO}_2 + \text{Fe}_2\text{O}_3$					
B hall	11.87	21.16	1.12	35.62	18.02	12.49	26.86	26.99	15.52	26.07	3.72	0.00	1.12	79.4	3.5+	41.4	<1/64 - 1/16
E 12	10.02	16.47	1.21	34.95	10.57	27.23	50.55	22.79	4.11	10.42	3.37	0.00	1.21	68.1	0.95+	40.0	1/16 - 3/32
E 106	11.52	17.54	0.60	36.87	14.89	1.99	40.84	26.20	11.74	19.88	1.15	0.00	0.60	92.3	2.0-	38.7	1/32 - 1/16
E 245	10.02	18.27	0.61	32.70	14.83	23.69	50.94	22.79	4.41	21.16	0.20	0.00	0.61	98.7	1.3-	3/47.9	1/32
E 316	10.62	23.34	2.18	34.58	16.86	12.70	27.31	24.15	16.06	24.39	0.00	3/6.19	3/2.18	100.0	3.3-	39.6	1/32 - 1/16
S 438	12.22	17.47	1.09	34.51	12.44	22.38	48.13	27.27	5.00	18.00	0.00	3/0.62	3/1.09	100.0	1.4-	39.8	1/16
W 504	4.41	21.01	0.70	32.24	12.77	29.03	62.43	10.03	8.31	18.47	0.00	3/ .22	3/0.70	100.0	0.81-	3/51.7	<1/64 - 1/16

¹ Letters signify, respectively: B, basement; E, north; S, east; W, south; W, west, and figures denote the room number as given on architectural plans.

² Samples designated E 245 and W 504, respectively, apparently show abnormally high percentages of MgO in the lime used. Possibly some vermiculite (a mineral containing a considerable percentage of MgO) from the base coat was carried mechanically into the white coat during the trowelling. If so, this would upset the validity of the calculations based on the assumption that the white coat consists of nothing other than lime and gypsum.

³ The excess H_2O may be attributed to unidentified minerals under $\text{SiO}_2 + \text{Al}_2\text{O}_3$.

Table 6. Plaster aggregates in set gypsum plaster
 (Computed from weights given in table 4)

Sample designation	Proportion of sand in aggregate	Aggregates per 100-lb bag of gypsum cement plaster	
		Vermiculite (10 lb/ft ³)	Sand (100 lb/ft ³)
B hall	90.0	3.0	.70
B 12	36.2	3.2	.12
L 106	0.0	2.0	.00
A 245	35.0	3.1	.17
E 316	46.0	3.9	.50
S 430	73.0	2.0	.53
L 504	45.3	2.7	.23

Year	Mean Temp. (°C.)	Mean Precip. (mm.)	Mean Humidity (%)	Mean Wind (km/h)
1960	18.0	1200	75.0	15.0
1961	18.2	1150	76.0	15.5
1962	18.4	1100	77.0	16.0
1963	18.6	1050	78.0	16.5
1964	18.8	1000	79.0	17.0
1965	19.0	950	80.0	17.5
1966	19.2	900	81.0	18.0
1967	19.4	850	82.0	18.5
1968	19.6	800	83.0	19.0
1969	19.8	750	84.0	19.5
1970	20.0	700	85.0	20.0
1971	20.2	650	86.0	20.5
1972	20.4	600	87.0	21.0
1973	20.6	550	88.0	21.5
1974	20.8	500	89.0	22.0
1975	21.0	450	90.0	22.5
1976	21.2	400	91.0	23.0
1977	21.4	350	92.0	23.5
1978	21.6	300	93.0	24.0
1979	21.8	250	94.0	24.5
1980	22.0	200	95.0	25.0
1981	22.2	150	96.0	25.5
1982	22.4	100	97.0	26.0
1983	22.6	50	98.0	26.5
1984	22.8	0	99.0	27.0
1985	23.0	0	99.5	27.5
1986	23.2	0	100.0	28.0
1987	23.4	0	100.5	28.5
1988	23.6	0	101.0	29.0
1989	23.8	0	101.5	29.5
1990	24.0	0	102.0	30.0
1991	24.2	0	102.5	30.5
1992	24.4	0	103.0	31.0
1993	24.6	0	103.5	31.5
1994	24.8	0	104.0	32.0
1995	25.0	0	104.5	32.5
1996	25.2	0	105.0	33.0
1997	25.4	0	105.5	33.5
1998	25.6	0	106.0	34.0
1999	25.8	0	106.5	34.5
2000	26.0	0	107.0	35.0
2001	26.2	0	107.5	35.5
2002	26.4	0	108.0	36.0
2003	26.6	0	108.5	36.5
2004	26.8	0	109.0	37.0
2005	27.0	0	109.5	37.5
2006	27.2	0	110.0	38.0
2007	27.4	0	110.5	38.5
2008	27.6	0	111.0	39.0
2009	27.8	0	111.5	39.5
2010	28.0	0	112.0	40.0
2011	28.2	0	112.5	40.5
2012	28.4	0	113.0	41.0
2013	28.6	0	113.5	41.5
2014	28.8	0	114.0	42.0
2015	29.0	0	114.5	42.5
2016	29.2	0	115.0	43.0
2017	29.4	0	115.5	43.5
2018	29.6	0	116.0	44.0
2019	29.8	0	116.5	44.5
2020	30.0	0	117.0	45.0
2021	30.2	0	117.5	45.5
2022	30.4	0	118.0	46.0
2023	30.6	0	118.5	46.5
2024	30.8	0	119.0	47.0
2025	31.0	0	119.5	47.5
2026	31.2	0	120.0	48.0
2027	31.4	0	120.5	48.5
2028	31.6	0	121.0	49.0
2029	31.8	0	121.5	49.5
2030	32.0	0	122.0	50.0
2031	32.2	0	122.5	50.5
2032	32.4	0	123.0	51.0
2033	32.6	0	123.5	51.5
2034	32.8	0	124.0	52.0
2035	33.0	0	124.5	52.5
2036	33.2	0	125.0	53.0
2037	33.4	0	125.5	53.5
2038	33.6	0	126.0	54.0
2039	33.8	0	126.5	54.5
2040	34.0	0	127.0	55.0
2041	34.2	0	127.5	55.5
2042	34.4	0	128.0	56.0
2043	34.6	0	128.5	56.5
2044	34.8	0	129.0	57.0
2045	35.0	0	129.5	57.5
2046	35.2	0	130.0	58.0
2047	35.4	0	130.5	58.5
2048	35.6	0	131.0	59.0
2049	35.8	0	131.5	59.5
2050	36.0	0	132.0	60.0
2051	36.2	0	132.5	60.5
2052	36.4	0	133.0	61.0
2053	36.6	0	133.5	61.5
2054	36.8	0	134.0	62.0
2055	37.0	0	134.5	62.5
2056	37.2	0	135.0	63.0
2057	37.4	0	135.5	63.5
2058	37.6	0	136.0	64.0
2059	37.8	0	136.5	64.5
2060	38.0	0	137.0	65.0
2061	38.2	0	137.5	65.5
2062	38.4	0	138.0	66.0
2063	38.6	0	138.5	66.5
2064	38.8	0	139.0	67.0
2065	39.0	0	139.5	67.5
2066	39.2	0	140.0	68.0
2067	39.4	0	140.5	68.5
2068	39.6	0	141.0	69.0
2069	39.8	0	141.5	69.5
2070	40.0	0	142.0	70.0
2071	40.2	0	142.5	70.5
2072	40.4	0	143.0	71.0
2073	40.6	0	143.5	71.5
2074	40.8	0	144.0	72.0
2075	41.0	0	144.5	72.5
2076	41.2	0	145.0	73.0
2077	41.4	0	145.5	73.5
2078	41.6	0	146.0	74.0
2079	41.8	0	146.5	74.5
2080	42.0	0	147.0	75.0
2081	42.2	0	147.5	75.5
2082	42.4	0	148.0	76.0
2083	42.6	0	148.5	76.5
2084	42.8	0	149.0	77.0
2085	43.0	0	149.5	77.5
2086	43.2	0	150.0	78.0
2087	43.4	0	150.5	78.5
2088	43.6	0	151.0	79.0
2089	43.8	0	151.5	79.5
2090	44.0	0	152.0	80.0
2091	44.2	0	152.5	80.5
2092	44.4	0	153.0	81.0
2093	44.6	0	153.5	81.5
2094	44.8	0	154.0	82.0
2095	45.0	0	154.5	82.5
2096	45.2	0	155.0	83.0
2097	45.4	0	155.5	83.5
2098	45.6	0	156.0	84.0
2099	45.8	0	156.5	84.5
2100	46.0	0	157.0	85.0

6. STABILITY OF LATH AND PLASTER FROM THE HOSPITAL BUILDING

Five of the 15- by 15-inch specimens of lath and plaster cut from partitions of the basement, first, third, and fifth stories of the hospital building were sawn into 3 inch wide strips and subjected alternately to high and low or low and high humidity at nearly constant temperature. Changes in length between gage points 10 inches apart on 1/4-inch diameter thin brass discs cemented to the front and back surfaces of the plaster were measured by means of an optical comparator which was calibrated against a 10-inch invar standard bar at the time each set of readings was made. The changes in length shown by the differences of readings of the comparator indicated an initial shrinkage of many specimens followed by expansion when placed in an atmosphere having high humidity and shrinkage when in a container having low humidity.

The changes of length of the specimens in terms of percentage of the 10-inch gage length are shown in figures 1 and 2. These are typical of the behavior of the twenty-two specimens subjected to the tests. In some instances there appeared to be evidence that the expansion of the plaster caused flexing of the lath, thus producing marked or anomalous differences in the lengthening or shortening of the gage length of the specimens during the period in which it was subjected to a constant humidity. Some of these anomalies have been attributed to cracking of the base-coat plaster or both the base-coat plaster and the white-coat finish, thus allowing the metal lath, already strained by the shrinking plaster, to regain its length to the extent that the strain from shrinkage of the plaster had been relieved.

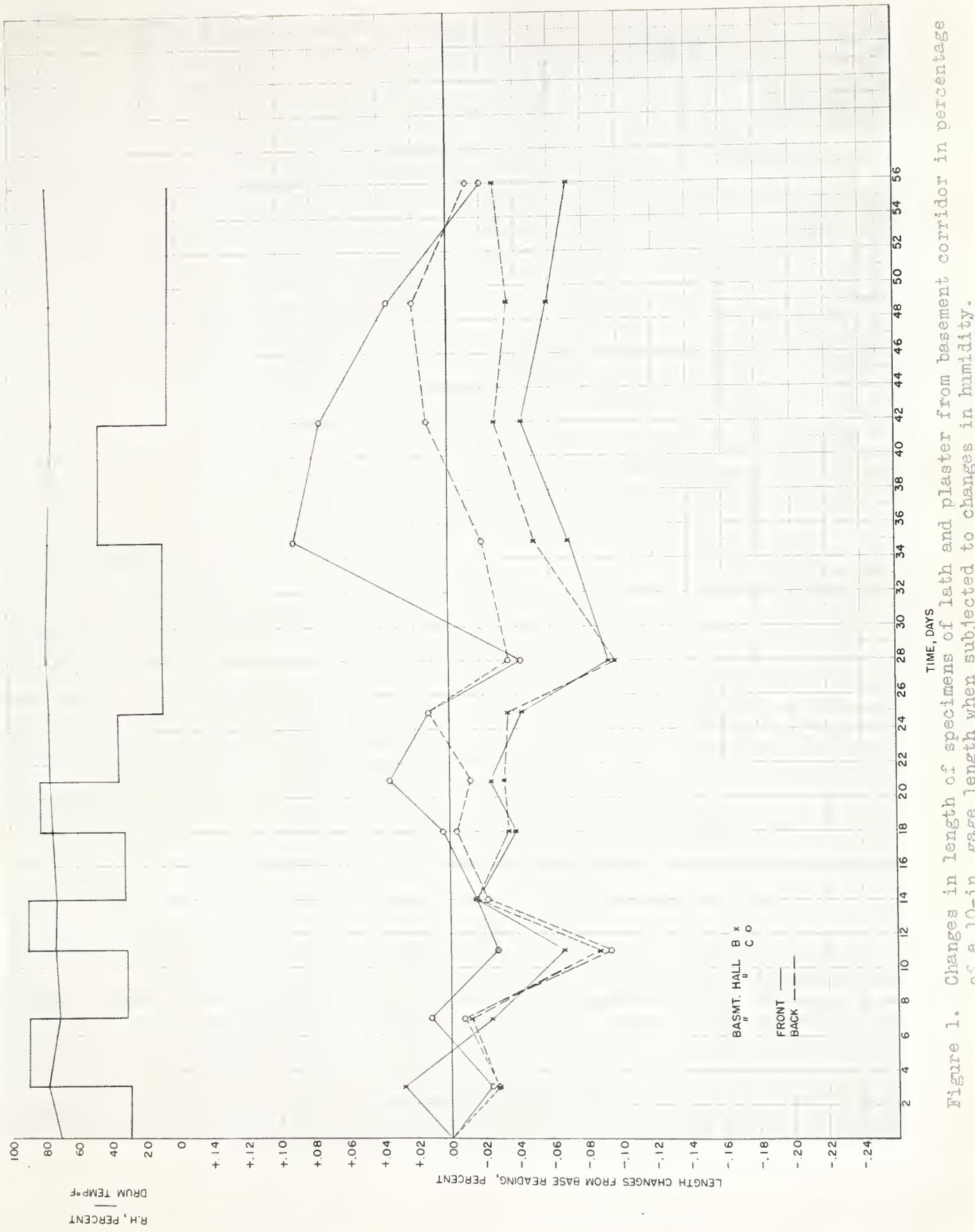


Figure 1. Changes in length of specimens of 18th and plaster from basement corridor in percentage of a 10-in. gage length when subjected to changes in humidity.



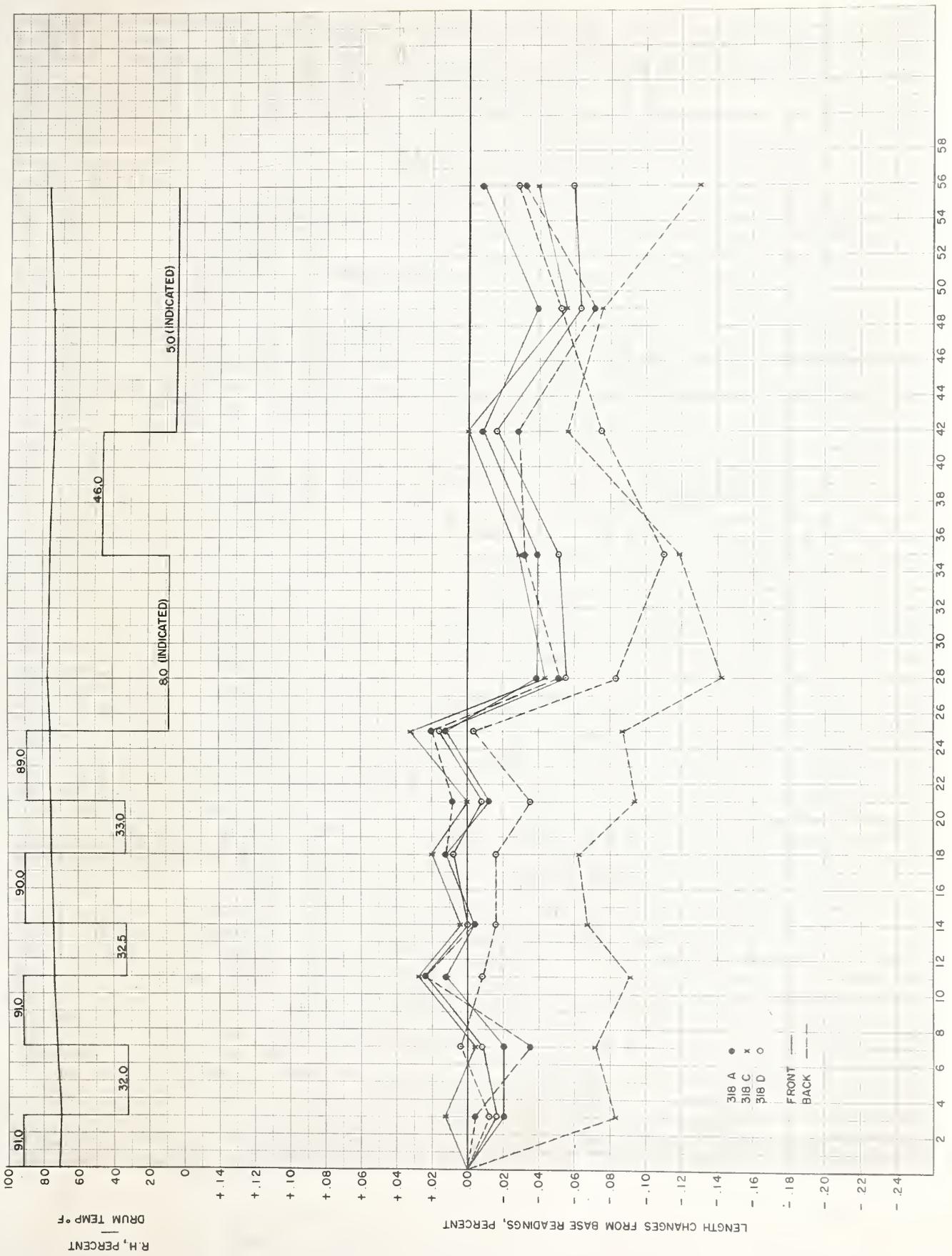


Figure 2. Changes in length of specimens of lath and plaster from room 318 in percentage of 1-in. base length when subjected to changes in humidity.

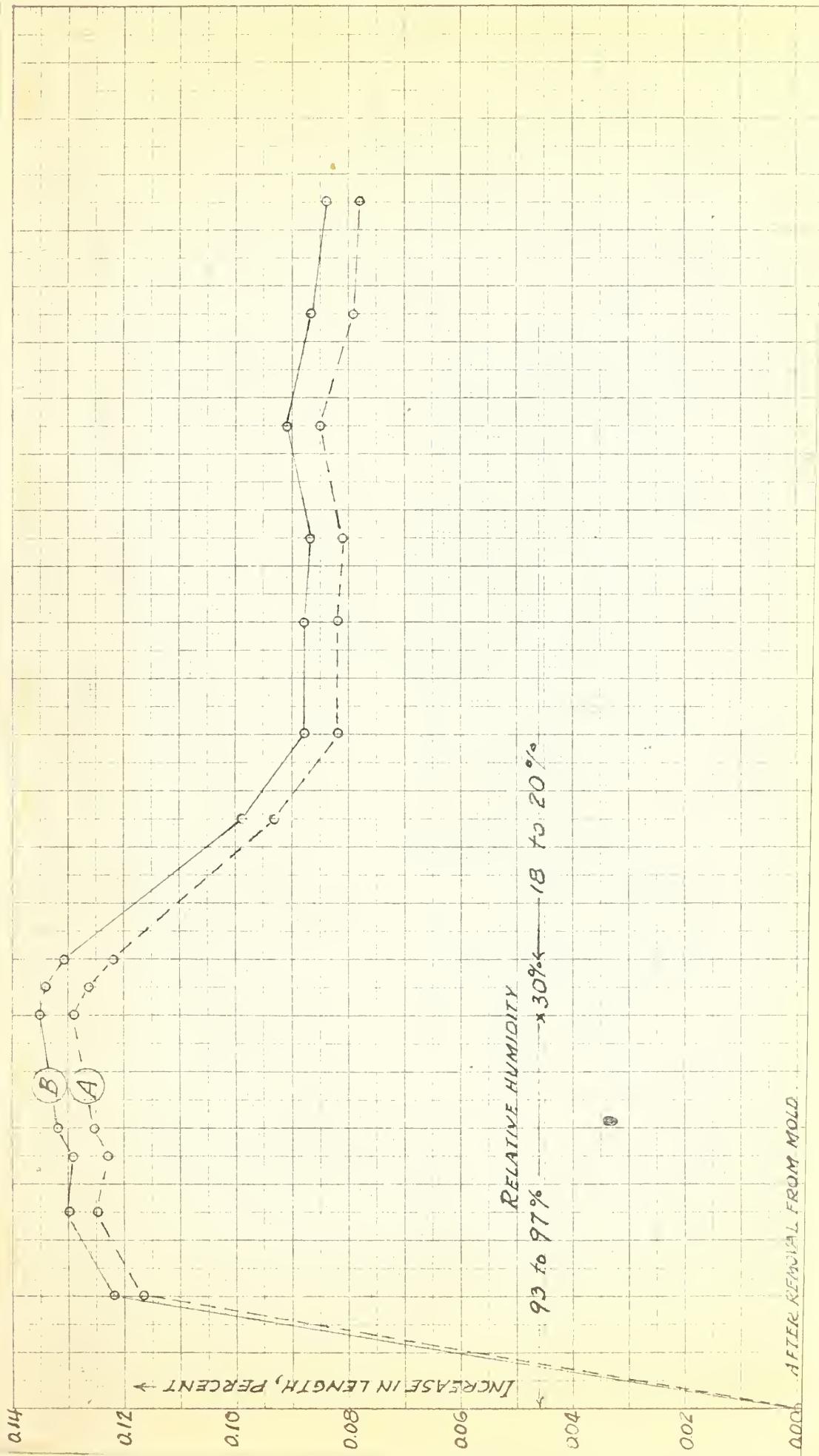


7. BEHAVIOR OF MOLDED PLASTER BARS

Two test bars of plaster designated A and B were cast in steel molds in order to study the behavior of the typical plaster mix when subjected to changing conditions of humidity. The bars were cast in molds to give an effective length of 10 inches between steel plugs cast into the ends of the bars. The bars were made from plaster having the composition: 20 parts fibered-gypsum cement, 8 parts vermiculite, and 5 parts Alaska sand by weight. Bar B had 10 percent more water in the mix than did bar A. The 1- by 7/8-inch bars had a 1/16 inch thick white finish applied to one face after they had been removed from the molds and measured for expansion. The changes in length of the two bars are shown in figure 3. On release from the constraint of the molds, the bars expanded 0.02 and 0.03 percent of their length at once, and after having lain horizontally without other restraint than their own weight for 4 days in a chamber at 70° F and at 93 to 97 percent relative humidity, the bars were found to have increased in length by 0.117 and 0.122 percent. During the next 10 days, at the same humidities, increases of 0.012 and 0.013 percent in length were observed, making the total expansion from the beginning of storage at high humidity 0.129 and 0.135 percent, respectively. The bars were then placed in a chamber held at 70° F and at 30 to 40 percent relative humidity for 2 days. The shrinkage during these 2 days amounted to not more than 0.007 percent. During the next 8 days, however, after storage in the chamber held at 18 to 20 percent relative humidity, the shrinkage amounted to 0.040 and 0.043 percent for specimens A and B, respectively. The shrinkage during the next 19 days, under the same humidity conditions, amounted to 0.004 percent. From the point of maximum expansion the shrinkage at the end of 29 days' storage in chambers in which the relative humidity was lowered by stages to 18 percent had reached 0.052 percent and appeared to be continuing.

que o seu eixo é o desenvolvimento rural da zona rural com
desenvolvimento social e econômico das cidades e regiões rurais.
O objetivo é integrar os efeitos da vida no campo com a vida
urbana, de forma que possa ser criado um novo tipo de cidadão.
Os resultados das ações devem ser sempre avaliados e
ajustados à base de indicadores objetivos, que medem a eficiência
da política rural e a eficiência social da mesma.
A estratégia para a implementação da política deve ser:
1) identificação das necessidades e prioridades locais;
2) elaboração de propostas de ação;
3) execução das ações;
4) avaliação das ações;
5) ajustamento das ações;
6) avaliação das ações.

A estratégia deve ser aplicada em todos os setores da economia
rural, tanto que o custo da terra é elevado (cerca de 20.000
reais por hectare), quanto que a terra é escassa (cerca de 100
milhares de hectares).
O custo da terra é elevado, mas a terra é escassa.
A estratégia deve ser aplicada em todos os setores da economia
rural, tanto que o custo da terra é elevado (cerca de 20.000
reais por hectare), quanto que a terra é escassa (cerca de 100
milhares de hectares).





8. FLEXURE OF LATH AND PLASTER

Twelve specimens for tests to determine the amount of flexure of metal lath and plaster resulting from expansion or shrinkage of the plaster under different conditions of humidity were prepared. These were made by attaching 5 1/2 inch wide by 36 inch long strips of 3.4 lb. expanded metal lath to 1/4-inch diameter steel uprights mounted on a 6 by 1/8 by 36 inch long steel base plate. The uprights were spaced 16 inches on centers in two rows of three each. Two of the uprights of each row were welded in place while those at one end were fitted into holes in the base, so as to be removable. The lath strips were wired to the uprights so that one end of the lath would be free to flex after the removable upright had been removed.

Each coat of the base-coat plaster applied was made up of 20 lb. gypsum cement plaster, 8 lb. vermiculite, and 5 lb. of Alaska sand. After the batch had been well mixed it was halved. To one half, 1 $\frac{1}{4}$ lb. of water was added to give a relatively stiff mixture; to the other, 15 1/2 lb. of water was added to produce a comparatively soft mixture. The plaster coats were applied to the lath strips on two successive days to 11/16-inch thickness as determined by wood grounds, the drier mix being applied to the lath on the right-hand side of the base. After storage under wet burlap over night, the 12 specimens were transferred, four to each of three humidity chambers. The relative humidities in the three chambers into which the specimens were placed were 52, 72, and 92 percent.

The large amount of water in the specimens increased for a time the relative humidity above those fixed by the saturated salt solutions intended to keep the humidity at a constant level. After 3 days' storage of the specimens, a white-coat finish consisting of 4 parts lime putty to 1 part gauging plaster was applied to the set base-coat plasters to thicknesses ranging from 1/16 to 1/8 inches. The specimens were returned to the humidity chambers as soon as the white-coat finish had been applied.

In the 60-hour interval between the application of the brown-coat plaster and the white-coat finish, the free ends of the metal lath strips made with the drier mix of plaster were deflected from their original positions by expansion of the plaster an average of 0.16 inch and those to which the wetter plaster was applied an average of 0.18 inch. After the application of the white-coat plaster the specimens continued to expand, thus causing increased deflections. A pair of specimens having plaster of the two degrees of wetting continued to deflect after 46 days in the chamber with high humidity. The specimen with the drier mix, and without white coat, has deflected 0.47 inch and the specimen having the wetter mix, with white coat, has deflected 0.14 inch. When placed in chambers conditioned to low humidity, the plaster shrank, thus causing the strips to be deflected in the opposite direction. The four specimens which have been in a chamber, the relative humidity of which has been lowered from 55 to 18 percent, have shrunk to cause deflections of the free ends ranging from 0.197 to 0.276 inch. The shrinkage continues.

and its consequences and examine how and why it has happened. This is the first step in the process of change. After a long period of time, the people will begin to understand what has happened and why. They will then start to take action to change their situation. This is the second step in the process of change. The third step is to continue to work on the changes that have been made. This is the final step in the process of change.

9. CONCLUSIONS

From the observations made during the inspections of the buildings and the subsequent as well as previous laboratory tests which indicated a high degree of dimensional instability of the plaster when subjected to the range of relative humidities not in excess of those encountered in buildings, it has been concluded that the cracking has resulted from this instability. The relative effects of shrinkage of the fibered gypsum cement plaster as revealed by the volumetric shrinkage of cubes of the neat and sanded plasters, items 4, 5, and 6, table 2, and the expansion and contraction of the plaster bars having both sand and vermiculite as the aggregate in causing the plaster to crack have not yet been determined. Doubtless both effects have played a part in causing cracks in the plaster. The measurements of change of length of specimens of the set plaster on metal lath by means of the comparator have shown that when subjected to large variations in relative humidity the base-coat plasters usually crack, and in a few cases the white-coat finish cracked also. Some of the 3 inch wide strips cut from the 15- by 15-inch specimen of lath and plaster taken from partitions in the hospital building exhibited decided curvature, which increased as the tests proceeded, indicating that the strength of the plaster was sufficient to cause progressive bending of the expanded metal lath. Some of these strips cracked during the tests, presumably when the strength of the plaster was not sufficient to cause further bending of the metal lath.

Although the studies have not been completed, we can, with reasonable assurance, say that the cracking of the plaster has resulted from dimensional instability of the combination of lath and weak plaster. Dimensional changes have doubtless been aggravated by the humidity conditions prevailing within the building during and subsequent to the plastering operations.

It is quite probable that cracking of the plaster on the metal lath partitions will continue through several seasons unless some process for stabilizing the plaster against excessive expansion and contraction with the changes in humidity to which it is normally subjected can be applied.

None of the contents of this report are released for publication or for use in sales promotion.

For the Director

Nolan D. Mitchell
Consultant, Building Technology Division



